

C L A I M S

What is claimed and desired to be secured by Letters Patent is as follows:

1. A workpiece inspection system for inspecting a succession of workpieces and comprising:
 - a) an image capture device positioned to define a workpiece inspection zone and to capture an image of a workpiece within said workpiece inspection zone;
 - b) a workpiece launching device positioned in spaced relation to said inspection zone and from which workpieces are successively launched to pass unsupported through said inspection zone; and
 - c) a controller communicating with said image capture device; said controller programmed to process an image of each workpiece as it passes through said inspection zone to detect a selected characteristic of the workpiece from the image and, if the selected characteristic is detected, to generate a workpiece action signal indicative of the presence of the selected characteristic in the respective workpiece.

2. The workpiece inspection system as in Claim 1 further comprising:
- a) a workpiece differentiating device communicating with said controller and acting relative to the respective workpiece in response to said workpiece action signal to differentiate the respective workpiece from workpieces for which said workpiece action signal has not been generated.
3. The workpiece inspection system as in Claim 1 further comprising:
- a) a workpiece path selection device communicating with said controller and positioned to engage the respective workpiece in response to said workpiece action signal to determine a subsequent path of movement of the workpiece.

4. A workpiece inspection system for consecutively inspecting a plurality of workpieces comprising:
- a) a camera positioned to capture an image of a workpiece in an inspection zone;
 - b) a launching device from which the workpieces may be consecutively launched to pass unsupported through said inspection zone;
 - c) a sensor positioned to sense when a workpiece has entered said inspection zone;
 - d) a controller communicating with said sensor and said camera and programmed to cause said camera to capture an image of the workpiece when said sensor senses the workpiece has entered said inspection zone; said controller programmed to analyze said image of the workpiece captured by the camera to identify any defects in the workpiece.

- 5) The workpiece inspection apparatus as in Claim 4 further comprising a diverter selectively operable to divert a workpiece from a first path of travel to a second path of travel after the workpiece passes through the field of view of the camera; said diverter communicating with said controller and said controller programmed to cause said diverter to divert to said second path of travel any work piece in which a defect has been identified by said controller.
6. A workpiece inspection system for consecutively inspecting a plurality of hollow workpieces, each workpiece including at least a first opening and said workpiece inspection system adapted to determine the presence of additional openings in said workpiece; said workpiece inspection system comprising:
- a) a plurality of cameras each positioned to capture image data of a workpiece in an inspection zone;
 - b) a launch tube from which the workpieces may be consecutively launched to pass unsupported through said inspection zone;
 - c) a light positioned to direct light into a workpiece through the first opening when the workpiece is located in said inspection zone;

d) a controller causing each of said cameras to capture an image of the workpiece when the workpiece has entered said inspection zone; said controller programmed to analyze the images of the workpiece captured by the cameras to determine the presence of any additional openings in the workpiece.

7. The workpiece inspection system as in Claim 6 wherein said light comprises a ring light secured around said launch tube.
8. The workpiece inspection system as in Claim 6 wherein said controller is further programmed to analyze the images of the workpiece captured by the cameras to determine the relative size of any additional openings in the workpiece and determine if the size of each additional opening complies with an established acceptable size for additional openings.

9. The workpiece inspection system as in Claim 6 comprising a diverter selectively operable to divert a workpiece from a first path of travel to a second path of travel after the workpiece passes through said inspection zone; said diverter communicating with said controller and said controller programmed to cause said diverter to divert to said second path of travel any workpiece identified by said controller as having an additional opening whose size does not comply with the established acceptable size for additional openings.
10. A workpiece inspection system for inspecting a succession of workpieces and comprising:
- a) image capture means positioned to capture an image of a workpiece within a field of view of said image capture means;
 - b) launching means for successively launching workpieces unsupported into the field of view of said image capture means; and

- c) a controller communicating with said image capture means; said controller programmed to cause said image capture means to capture an image of each workpiece as it passes into the field of view of said image capture means and to analyze the captured image to detect a selected characteristic of the workpiece from the captured image and, if the selected characteristic is detected, to generate a workpiece action signal indicative of the presence of the selected characteristic in the respective workpiece.

11. The workpiece inspection system as in Claim 10 further comprising:

- a) illumination means for illuminating each workpiece as it passes into the field of view of said image capture means.

12. The workpiece inspection system as in Claim 10 further comprising:

- a) diverting means for diverting a workpiece for which a workpiece action signal has been generated from a first path of travel to a second path of travel.

13. A process for inspecting a succession of workpieces and comprising the steps of:

- a) positioning a camera to define a workpiece inspection zone and to capture an image of a workpiece within said workpiece inspection zone;
- b) successively launching workpieces unsupported through said inspection zone;
- c) capturing a respective image of each workpiece launched through said inspection zone; and
- d) processing each image by a computer to detect the presence of a selected characteristic in the respective workpiece from the image.

14. The workpiece inspection system as in Claim 13 further comprising the step of:

- a) differentiating the workpieces for which the presence of the selected characteristic has been detected from the workpieces for which the presence of the selected characteristic has not been detected.

15. The workpiece inspection system as in Claim 13 further comprising the step of:

- a) directing the workpieces for which the presence of the selected characteristic has been detected to a first area and directing the workpieces for which the presence of the selected characteristic has not been detected to a second area.

16. A process for inspecting a plurality of workpieces comprising the steps of:

- a) consecutively launching the workpieces to pass unsupported past a field of view of a camera;
- b) sensing when each workpiece passes within the field of view of the camera;
- c) upon sensing each workpiece passing within the field of view of the camera, capturing image data of the workpiece with the camera;
- d) analyzing the captured image data to determine if the captured image data indicates the presence of a selected characteristic of said workpiece;
- e) upon determining that the captured image of a workpiece does not indicate unacceptable defects in the workpiece, directing the workpiece to a first area; and

f) upon determining that the captured image of a workpiece does indicate unacceptable defects in the workpiece, directing the workpiece to a second area.

17. The process for inspecting a plurality of workpieces as in Claim 16 further comprising the step of:

a) illuminating each workpiece.

18. The process for inspecting a plurality of workpieces as in Claim 16 further comprising the step of:

a) illuminating each workpiece simultaneously with the step of capturing the image of the workpiece with the camera and in response to sensing the workpiece passing within the field of view of the camera.

19. The process for inspecting a plurality of workpieces as in Claim 16 wherein the workpieces are hollow and include a first opening and the workpieces are inspected to detect additional openings; the process further comprising the step of:

a) internally illuminating each workpiece through the first opening simultaneously with the step of capturing the image of the workpiece with the camera and in response to sensing the workpiece passing within the field of view of the camera.

20. The process as in Claim 19 wherein said workpieces are inspected to detect additional openings which are larger than a specified opening wherein the step of analyzing the captured image comprises measuring the size of areas in the captured images in which the intensity of the light exceeds a specified intensity and comparing the measured size versus a minimum acceptable size.

21. The process as in Claim 16 wherein the camera comprises one of a plurality of cameras.

22. The process as in Claim 16 wherein the step of launching the workpieces past the field of view of a camera comprises dropping the workpiece past the field of view of the camera.
23. The process as in Claim 16 wherein the step of launching the workpiece past the field of view a camera comprises accelerating each workpiece downward and releasing the workpiece to drop past the field of view of the camera.
24. A process for inspecting a plurality of workpieces comprising the steps of:
- a) consecutively launching the workpieces to pass unsupported past a field of view of each of a plurality of cameras, each camera positioned and focused to record a different view of each workpiece as it passes within the field of view of the camera;
 - b) sensing when each workpiece passes within the field of view of the cameras;
 - c) upon sensing each workpiece passing within the fields of view of the cameras, simultaneously

illuminating the workpiece and causing each camera to capture an image of the workpiece;

- d) analyzing the captured images of each workpiece to determine if the images indicates unacceptable defects in the workpiece;
- e) upon determining that the captured images of a workpiece do not indicate unacceptable defects in the workpiece, directing the workpiece to a first area; and
- f) upon determining that the captured images of a workpiece do indicate unacceptable defects in the workpiece, directing the workpiece to a second area.

25. The process for inspecting a plurality of workpieces as in Claim 24 wherein the workpieces are hollow and include a first opening and the workpieces are inspected to detect additional openings; the process further comprising the step of: -

- a) internally illuminating each workpiece through the first opening simultaneously with the step of capturing the image of the workpiece with the camera and in response to sensing the workpiece passing within the field of view of the cameras.

26. The process as in Claim 25 wherein said workpieces are inspected to detect additional openings which are larger than a specified opening wherein the step of analyzing the captured images comprises measuring the size of areas in the captured images in which the intensity of the light exceeds a specified intensity and comparing the measured size versus a minimum acceptable size.
27. The process as in Claim 24 wherein the step of launching the workpieces past the field of view of the cameras comprises dropping the workpiece past the field of view of the cameras.
28. The process as in Claim 24 wherein the step of launching the workpiece past the field of view the cameras comprises accelerating each workpiece downward and releasing the workpiece to drop past the field of view of the cameras.